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ABSTRACT

This study was designed to determine the relationship between the Lowenfeldian visual-haptic (perceptual) and the Piagetian concrete-formal (operational reasoning) continua. The study also investigated the relationship between age, sex, academic goal, academic preference, and a person's perceptual aptitude or intellectual reasoning abilities. Subjects of the study were 312 university students. The instruments collected data on age, sex, academic goal, academic preference, position on the concrete-formal continuum, and position on the visual-haptic continuum. The following conclusions were drawn: (1) There is a relationship between the Lowenfeldian visual-haptic continuum and the Piagetian concrete-formal continuum; (2) Age is related to both perceptual aptitude and intellectual level in a curvilinear manner; (3) Findings support the idea that sex is related to intellectual level and that, generally, males are more abstract thinkers than females; (4) Males are more visually oriented than females; (5) Academic preference is not a viable predictor of either perceptual aptitude or intellectual level; (6) The more visually oriented or the more intellectually advanced an individual is, the higher that individual's eventual academic goal is likely to be; (7) Longeot's Piagetian Classification Test is hierarchical and therefore capable of identifying a location within the concrete-formal continuum; (8) Some very formal people override the generally linear relationship between concrete-formal and visual-haptic abilities, and these individuals, while being very abstract thinkers, may be haptically oriented. (JD)

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A Study of a Possible Relationship Between Lowenfeld's Visual--Haptic Theory and Piaget's developmental theory

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INTRODUCTION

Science educators, for a number of years, have been studying the development of logical thinking and perceptual abilities required to accomplish measurements, observations, classifications, and other scientifically related tasks. The developmental theory of the Swiss empiriacal epistemologist, Jean Piaget, provides much information concerning the development of these logical structures. On the other hand, the perceptual theory of the art educator and psychologist, Viktor Lowenfeld, provides information which has been useful in looking at perception. This study seeks to investigate the possible relationships between these theories.

Piaget (1936, 1954, 1962, 1967, 1972), Piaget and Inhelder (1947) and Inhelder and Piaget (1958) identified four stages of intellectual development as individuals progress from birth to adulthood. They named the two stages existent in school aged children and older people, concrete operational and formal operational.

Piaget (1972) believed his four developmental stages, describe a continuous process of intellectual growth. He stated that:

> Intellectual structures between birth and the period of 12-15 years grow slowly, but according to stages of development. The order of succession of these stages has been shown to be extremely regular and comparable to the stages of an embryogenesis.

He further pointed out that the speed of development could vary between individuals and social environments, but, the variation did not alter the sequence of stages.

According to Piaget, the child enters the concrete operational stage at about seven to eight years of age. In 1972, Piaget characterized the stage as follows:

> ...the child is capable of certain logical reasoning processes but only to the extent of applying particular operations to concrete objects in the immediate present: in other words, the operatory form of the reasoning process, at this level, is still subordinate to the concrete context that makes up the real world.

At between 11 and 12 years of age children enter the formal operational stage. Piaget (1972) stated that:

> The principal novelty of this period is the capacity to reason in terms of verbally stated hypotheses and no longer merely in terms of their manipulation. This is the decisive turning point, because to reason hypothetically and to deduce the consequences that the hypotheses necessarily imply (independent of the intrinsic truth or falseness of the premises) is a formal reasoning process.

Lowenfeld (1939, 1945, 1959, 1952, 1957), Lowenfeld and Brittain (1965, 1970, 1975), and "Are You Haptical", (1945) identified two types of perceptual aptitude which exist in an adult population. They labeled these types the visual and the haptic and stated that the extremes of each type occupied the antipodes of a continuum. Further, the antipodes could be identified by a specific set of characteristics, and individuals who fell between the antipodes exhibited varying amounts of each set of characteristics.

Extremely visually oriented individuals use their eyes as the main intermediaries of sense impressions whereas, haptically perceptive people, although of normal visual acuity, use their eyes as intermediaries of sense impressions only when forced to do so. The main mode of sensory input for haptically inclined people is kinesthetic-tactile. Therefore, visual ability is not necessarily the criterion for being visually oriented. Bedgone (1961) illustrates the point by explaining that visual perception is not merely a matter of seeing, but consists of two functions; seeing and observing. The seeing function involves the acuity level of the eyes, while the observing function is a psychological matter deeply rooted in the receptive capacity of the individual.

Visually oriented people are observers or spectators of their environment. They view their surroundings with an extreme degree of psychological detachment which prevents forming immediate attachments to those surroundings. The haptically oriented; however, are wholly subjective viewers of their environment. Whenever haptics react to their environment it is on a value basis; therefore, each encounter is conducted on an emotional level. If, for example, a group of people were asked to respond to transitive gerunds such as running or climbing, with the first thought that came to mind, the visuals might respond with nouns such as "track" or "mountain" while the haptic responses might be "hard" or "difficult."

When looking out the side window of a moving automobile or train, people do not see an entire scene during a single time frame but a series of partial impressions. Visually oriented people integrate these partial or successive panoramic impressions into coherent wholes with a great degree of facility while haptics do not.

Visual people take scenes in as unified wholes without an awareness of their details. Once an overview of a scene has been obtained, the component parts are analyzed and a new whole is synthesized. For example, when visually oriented people fly over airports, they first see an outline of the entire facility, then the individual runways and finally, the runway pattern. Haptically oriented people, on the other hand, quickly lose orientation to the field and become lost in the airport's details without ever having obtained an overview.

Unlike their visually oriented counterparts, the haptically oriented do not transform their kinesthetic-tactile impressions into visual experiences, but are content to leave them in the kinesthetic-tactile modality.

Statement of the Problem

This study was designed to determine the relationship between the Lowenfeldian visual-haptic (perceptual) and the Piagetian concrete-formal (operational resoning) continua. The study also investigated the relationship between age, sex, academic goal, and academic preference and a person's perceptual aptitude or intellectual reasoning abilities. Finally, the Guttman scaling ability of the Longeot (Piagetian Classification) test was investigated.

Procedures

The study involved the administration of three instruments to a combined sample of 312 students from the University of Maine, Orono, Maine; Husson College, Bangor, Maine; Maine Maritime Academy, Castine, Maine; Norwich University, Northfield, Vermont; and Drake University, Des Moines, Iowa. The instruments were; a questionnaire to collect age, sex, academic goal, and academic preference information on each subject; Longeot's (1962, 1965) Piagetian Classification Test to measure the subject's location on the concrete-formal continuum and; Lowenfeld's (Gibson, 1947) Successive Perception Test to measure the subject's location on the visual haptic continuum. The instruments were administered by volunteers, and all directions necessary for the completion of the instruments were provided for the subjects on a prerecorded cassette tape.

Methods of Data Analysis

All of the data were manipulated according to the procedures set forth in Statistical Package for the Social Sciences, (Nie, et al., 1975).

The relationship between the visual-haptic and the concrete-formal continua was evaluated using a Pearson Product Moment Correlation, a scatter

diagram, the eta statistic, the polynomial trends option of the regression analysis technique, and the segregation of subjects into concrete-haptic, concrete-visual, formal-haptic, and formal-visual cells based upon their Successive Perception Test and Piagetian Classification Test scores.

Pearson Product Moment correlations, scatter diagrams, and the eta statistic were used to evaluate the relationships between age and perceptual aptitude, and age and intellectual reasoning abilities.

Fisher's F-tests were used to evaluate the relationships between sex, academic goal, and academic preference and an individual's position on either the visual-haptic or the concrete-formal continuum.

Research Questions and Specific Findings

This section includes a statement of the research questions, and the specific findings related to each question.

1. Is there a relationship between an individual's position on the visual-haptic continuum and his position on the concrete-formal continuum?

A Pearson r of .34 (r^2 = .11, $p \leq .00001$) was obtained when Successive Perception Test scores were compared with Piagetian Classification Test scores. A scatter diagram of the relationship, however, suggested it to be curvilinear. Curvilinearity was confirmed by comparing the eta^2 (.22) (Mueller, & Schuessler, 1961) value for the relationship (eta = .47 with the Piagetian Classification Test as the dependent variable) with the r^2 derived from the Pearsonian r ($eta^2 \neq r^2$). The eta^2 value attributed 22% of the intellectual level variation to perceptual aptitude.

INSERT TABLE 1 HERE

2. Is there a relationship between age and the individual's position on either continuum?

The correlation between age and Successive Perception Test scores was -.18 (r^2 = .03), and the correlation between age and the Piagetian Classification Test scores was -.04 (r^2 = .002). Inspection of the scatter diagrams for both age with the Successive Perception Test and age with the Piagetian Classification Test show each comparison to be nonlinear. This was confirmed by comparing the eta^2 values for both relationships with the r^2 values for both. The eta^2 value for the age-Successive Perception Test comparison was .36 (eta = .60) and the eta^2 value for the age-Piagetian Classification Test score relationship was .436 (eta = .66). The eta^2 values attributed 36% of the variation in perceptual aptitude to age and 43.6% of the variation in intellectual level to age.

INSERT TABLE 2 HERE

3. Is there a relationship between sex and the position an individual occupies on either continuum?

F-tests were run on the sex with Successive Perception Test and sex-Piagetian Classification Test relationships. The F-values respectively for these relationships were 9.60 (p = .002) and 6.28 (p = .01). Males were more visually oriented and more formally operational than females.

INSERT TABLE 3 HERE

4. Is there a relationship between academic preference and a person's location on either continuum?

Academic preferences were compared on both the Successive Perception Test and the Piagetian Classification Test using a oneway analysis of variance. The relationship on the Successive Perception Test was found to be significant at the .001 level ($F = 5.0274$). The comparison on the Piagetian Classification Test was significant at the .002 level ($F = 3.428$).

The academic preference categories arranged from lowest to highest mean perceptual aptitude score were, mathematics, business subjects, social sciences, languages, fine arts, biological sciences, physical sciences, and history. The arrangement based upon mean intellectual level score was business, fine arts, social sciences, physical sciences, mathematics, biological sciences, and languages (there was a void in the history category of the Piagetian Classification Test because of an absence on the day the instrument was administered).

INSERT TABLE 4 HERE

5. Is there a relationship between academic goal and a person's position on either continuum?

F-tests were run on the academic goal with Successive Perception Test and academic goal-Piagetian Classification Test relationships. The F-values for these relationships respectively were 2.339 ($p = .07$) and 3.428 ($p = .002$). In order of increasing mean Successive Perception Test and Piagetian Classification Test scores, the academic goal categories were AAS, BS, MS, and doctorate.

INSERT TABLE 5 HERE

6. Do subjects segregate as, (a) concrete-haptic, (b) concrete-formal, (c) formal-haptic, (d) formal-visual?

Subjects were found to segregate into these categories when divided at the mean Successive Perception Test score (17.9) and the mean Piagetian Classification Test score (19.7). The segregation was as follows, (a) concrete-haptic, 26%, (b) concrete-visual, 16%, (c) formal-haptic, 23% (d) formal-visual, 35%.

INSERT TABLE 6 HERE

7. Is there an equation which will allow prediction of intellectual level based upon perceptual aptitude?

A stepwise multiple regression analysis was run using the polynominal trends option (Piagetian Classification Test scores were used as the dependent variable) to produce a predictor equation based upon a line which best fit the data. The regression analysis used the first, second, third, and fourth powers of perceptual aptitude as independent variables. The equation derived from this technique was; intellectual level = 31.04 + 5.17 (perceptual aptitude) + $(1\text{-}.19)^2$ (perceptual aptitude)^2 + $(.002)^3$ (perceptual aptitude)^3. This equation had a standard error of 1.91, and attributed 83% of the intellectual level variance to perceptual aptitude.

INSERT FIGURE 1 HERE

8. Does the Piagetian Classification Test scale?

The instrument formed a hierarchial scale (Gulbman, 1944) in which all of the formal level items except item number 20 were more difficult than all of the concrete level items. Item number 20 was found to be less difficult than concrete level items number five, 14, and 22.

Finally, the reliabilities for the Successive Perception Test and Piagetian Classification Test were .62, and .859 respectively.

INSERT TABLE 7 HERE

Interpretations and Implications of the study

The major finding of the study was that perceptual aptitude and intellectual level were related in a curvilinear manner which attributed 83% of their variance to some common factor. The curviliniar model of the relationship in this study had two inflections (the number of inflections is always one less than the highest powered exponent in an equation). This finding was unexpected; however, it does support and in turn is supported by the fact that the subjects were categorizible as concrete-haptic, concrete-visual, formal-haptic, and formal-visual. The use of perceptual aptitude as a predictor of intellectual level and the converse, however, should be used with caution unless the curvilinearity of the relationship is fully understood.

A second finding was that age and perceptual aptitude and age and intellectual level were related in a curvilinear manner. It was expected that a positive relationship would be found between age and intellectual level, since according to Piaget (1972) not everyone is expected to be fully formal by age

15 or 16; success in attaining this level by this age may be couched in socioeconomic background.

Another finding was that to some extent academic goal is a viable predictor of either perceptual level or intellectual level. However, when a high perceptual aptitude or intellectual level is suggested using academic goal as a predictor, it does not necessarily follow that a high perceptual aptitude or intellectual level socre will also be obtained.

The finding that age was curvilinearly related to perceptual aptitude tends to support Flick's (personal communication, July 8, 1976) observation that as individuals advance in age, they tend to become more visual and that at some age, their perceptual aptitudes start to shift in a haptic direction.

The results of the study show a significant relationship between sex and both perceptual aptitude and intellectual level. Males are more visually oriented and more abstract thinkers than females. There is little documentary evidence in the case of perceptual aptitude to support or differ with the sex related finding of this study. The sex-intellectual level finding of this study is in agreement with Elkind (1961), Field (1969), Piburn (1977), and Heller (1977).

The usefulness of academic preference as a predictor of perceptual aptitude or intellectual level is questionable based upon the results of this study. However, the use of academic preference as a predictor lessened because all of the subjects from Maine Maritime Academy preferred the physical sciences, and all the subjects from Norwich University and Drake University preferred the social sciences. Before this variable can be categorically ruled out as a predictor of either perceptual aptitude or intellectual level, the topic needs more research.

The results of the scaling technique showed the Piagetian Classification Test to form a Guttman scale except in the case of test item number 20. Item 20 was the only formal item found to be less difficult than all of the concrete level items. It was less difficult than concrete items five, 14, and 22 not only because of the number of subjects successfully answering the item but also because of the number of subjects passing the item that should have failed it and the number of subjects failing the item who should have passed it (based upon subject performance in responding to items previous to this one). The results of the scaling technique suggest that the Piagetian Classification Test provides a reasonable measure of an individual's location on the concrete-formal continuum.

Conclusions

The following conclusions can be drawn from the finding of this study.

1) The results support the idea that there is a relationship between the Lowenfeldian visual-haptic continuum and the Piagetian concrete-formal continuum. The model of the relationship is curvilinear and in the case of this study, the best fit line had two inflections. In addition, the curvilinear model of the perceptual aptitude intellectual ability accounts for a major portion of the observed variance between the two continua.

2) Age is related to both perceptual aptitude and intellectual level in a curvilinear manner.

3) The findings support the idea that sex is related to intellectual level, and that generally, males are more abstract thinkers than females.

4) The findings of this study suggest that males are more visually oriented than females.

5) Academic preference is not a viable predictor of either perceptual aptitude or intellectual level.

6) The finding suggest that a specific academic goal may be predictive of an individual's perceptual aptitude and intellectual level. However, it may also be concluded that since academic goal has not yet been reached at the time an individual states the goal, both perceptual aptitude and intellectual level are predictive of academic goal. The more visually oriented or the more intellectually advanced an individual is, the higher that individual's eventual academic goal is likely to be.

7) The data supports the idea that Longeot's Piagetian Classification Test is hierarchical and therefore capable of identifying a location within the concrete-formal continuum.

8) The categorization of subjects into a four cell concrete-haptic, concrete-visual, formal-haptic, and formal-haptic matrix, suggests that some very formal people override the generally linear relationship between concrete-formal and visual-haptic abilities. These individuals, while being very abstract thinkers may be haptically oriented. This finding supports the findings of Roe (1952).

9) The curvilinear finding between concrete-formal and visual-haptic abilities suggests that there is a need for reevaluation of much of the data collected by previous researchers. It might be hypothesized that some strong relationships would be found between the concrete-formal and field-dependent-field-independent, and between field-dependent-field-independent and visual-haptic continua if the data of former researchers were evaluated using curvilinear techniques.

Table 1

Product Moment Correlation and Eta Values for the Comparison Between the Successive Perception Test and Piagetian Classification Test

	Mean	SD	Significance of r	r	r^2	eta	eta^2	Number of Observations
Successive Perception Test	17.8	4.7	.00001	.34	.11	.47	.22	279
Piagetian Classification Test	19.7	4.6						284

Table 2

Product Moment Correlation and Eta Values for the Relationships Between Age and Successive Perception Test scores and Age and Piagetian Classification Test Scores

	Mean	SD	Significance of r	r	r^2	eta	eta^2
Age	255.5	56.6	.002				
Succssive Perception Test			.55	-.18	.03	.60	.36
Piagetian Classification Test				-.04	.001	.66	.436

Table 3

Means, Standard Deviations, and F Values for the Comparisons Between Males' and Females' Scores on the Successive Perception Test and the Piagetian Classification Test

	Successive Perception Test		Piagetian Classification Test	
	Male	Female	Male	Female
Mean Score	18.96	17.1	20.4	19.1
Standard Deviation	4.65	4.71	4.1	4.97
No. of Observations	152	127	151	131
F Value	9.60		6.28	
Signif. of F	.002		.01	

Table 4

Means, Standard Deviations, and F Values for the Comparisons Between Academic Preference Categories on the Successive Perception Test and the Piagetian Classification Test

	Successive Perception Test			Piagetian Classification Test		
	Mean	SD	# of Ob.	Mean	SD	# of Ob.
Phy Sci	19.9	4.2	104	20.5	3.9	104
Bio Sci	19.0	3.3	10	21.8	3.1	9
Math	14.5	5.3	4	21.8	6.1	4
Languages	17.1	4.4	8	22.3	2.1	7
Soc Sci	16.7	3.8	64	20.4	5.0	64
Fine Arts	18.8	5.6	6	20.0	5.6	5
History	20.0	0.0	1			
Bus Subj	16.4	5.4	80	17.7	4.8	71
F Values	5.0274			3.428		
Sign. of F	.001			.002		

Table 5

Means, Standard Deviations, and F Values for the Comparisons Between Test and the Piagetian Classification Test

	Successive Perception Test			Piagetian Classification Test		
	Mean	SD	# of Ob.	Mean	SD	# of Ob.
AAS	17.0	4.6	69	16.8	4.3	64
BS	17.9	4.6	136	20.7	4.4	129
MS	18.7	5.1	67	21.0	4.2	66
Doctorate	21.4	5.9	5	21.4	4.9	5
F Values	2.349			3.428		
Sign. of F	.07			.002		

Table 6

Concrete-Haptic, Concrete-Visual, Formal-Haptic, and Formal-Visual Cell Frequencies and Percentages

	Concrete (0-19)	Formal (20-28)
Haptic (0-17)	66, 26%	58, 23%
Visual (18-35)	41, 16%	89, 35%

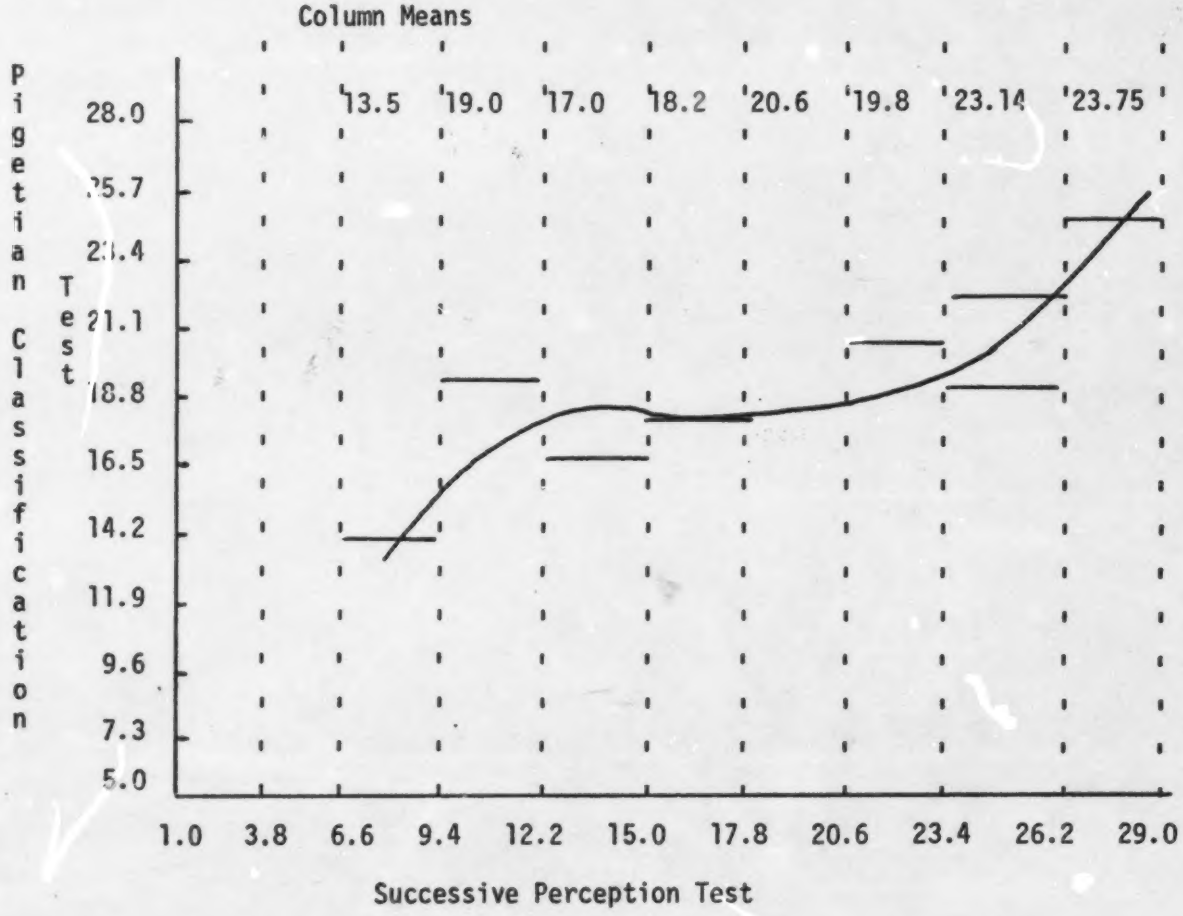

Figure 1

Curvilinear Relationship Between Successive Perception Test and Piagetian Classification Test Scores

Table 7

Scaling of Piagetian Classification Test Items From Least to Most Difficult

Test Item No.	Item Type	No. Passing Item	% Passing Item	No. Failing Item	% Failing Item	
1	C	268	93	20	7	
13	C	267	93	21	7	
3	C	265	92	23	8	I
12	C	263	91	25	9	N
4	C	263	91	25	9	C
21	C	261	91	27	9	R
15	C	257	89	31	11	E
2	C	254	88	34	12	A
23	C	253	88	35	12	S
20	F	248	86	40	14	I
14	C	248	86	40	14	N
5	C	248	86	40	14	G
22	C	246	85	42	15	
19	F	232	81	56	19	
25	F	220	76	68	24	D
16	F	213	74	75	26	I
18	F	197	68	91	32	F
24	F	193	67	95	33	F
17	F	191	66	97	34	I
9	F	165	57	123	43	C
26	F	149	52	139	48	U
6	F	148	51	140	49	L
7	F	136	47	152	52	T
28	F	133	46	155	54	Y
27	F	122	42	166	58	
10	F	112	39	176	61	
11	F	103	36	185	64	
8	F	17	6	271	91	

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According to Piaget, the child enters the concrete operational stage at about seven to eight years of age. In 1972, Piaget characterized the stage as follows:

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> The principal novelty of this period is the capacity to reason in terms of verbally stated hypotheses and no longer merely in terms of their manipulation. This is the decisive turning point, because to reason hypothetically and to deduce the consequences that the hypotheses necessarily imply (independent of the intrinsic truth or falseness of the premises) is a formal reasoning process.

Lowenfeld (1939, 1945, 1959, 1952, 1957), Lowenfeld and Brittain (1965, 1970, 1975), and "Are You Haptical", (1945) identified two types of perceptual aptitude which exist in an adult population. They labeled these types the visual and the haptic and stated that the extremes of each type occupied the antipodes of a continuum. Further, the antipodes could be identified by a specific set of characteristics, and individuals who fell between the antipodes exhibited varying amounts of each set of characteristics.

Extremely visually oriented individuals use their eyes as the main intermediaries of sense impressions whereas, haptically perceptive people, although of normal visual acuity, use their eyes as intermediaries of sense impressions only when forced to do so. The main mode of sensory input for haptically inclined people is kinesthetic-tactile. Therefore, visual ability is not necessarily the criterion for being visually oriented. Bedgone (1961) illustrates the point by explaining that visual perception is not merely a matter of seeing, but consists of two functions; seeing and observing. The seeing function involves the acuity level of the eyes, while the observing function is a phychological matter deeply rooted in the receptive capacity of the individual.

Visually oriented people are observers or spectators of their environment. They view their surroundings with an extreme degree of psychological detachment which prevents forming immediate attachments to those surroundings. The haptically oriented; however, are wholly subjective viewers of their environment. Whenever haptics react to their environment it is on a value basis; therefore, each encounter is conducted on an emotional level. If, for example, a group of people were asked to respond to transitive gerunds such as running or climbing, with the first thought that came to mind, the visuals might respond with nouns such as "track" or "mountain" while the haptic responses might be "hard" or "difficult."

When looking out the side window of a moving automobile or train, people do not see an entire scene during a single time frame but a series of partial impressions. Visually oriented people integrate these partial or successive panoramic impressions into coherent wholes with a great degree of facility while haptics do not.

Visual people take scenes in as unified wholes without an awareness of their details. Once an overview of a scene has been obtained, the component parts are analyzed and a new whole is synthesized. For example, when visually oriented people fly over airports, they first see an outline of the entire facility, then the individual runways and finally, the runway pattern. Haptically oriented people, on the other hand, quickly lose orientation to the field and become lost in the airport's details without ever having obtained an overview.

Unlike their visually oriented counterparts, the haptically oriented do not transform their kinesthetic-tactile impressions into visual experiences, but are content to leave them in the kinesthetic-tactile modality.

Statement of the Problem

This study was designed to determine the relationship between the Lowenfeldian visual-haptic (perceptual) and the Piagetian concrete-formal (operational resoning) continua. The study also investigated the relationship between age, sex, academic goal, and academic preference and a person's perceptual aptitude or intellectual reasoning abilities. Finally, the Guttman scaling ability of the Longeot (Piagetian Classification) test was investigated.

Procedures

The study involved the administration of three instruments to a combined sample of 312 students from the University of Maine, Orono, Maine; Husson College, Bangor, Maine; Maine Maritime Academy, Castine, Maine; Norwich University, Northfield, Vermont; and Drake University, Des Moines, Iowa. The instruments were; a questionnaire to collect age, sex, academic goal, and academic preference information on each subject; Longeot's (1962, 1965) Piagetian Classification Test to measure the subject's location on the concrete-formal continuum and; Lowenfeld's (Gibson, 1947) Successive Perception Test to measure the subject's location on the visual haptic continuum. The instruments were administered by volunteers, and all directions necessary for the completion of the instruments were provided for the subjects on a prerecorded cassette tape.

Methods of Data Analysis

All of the data were manipulated according to the procedures set forth in Statistical Package for the Social Sciences, (Nie, et al., 1975).

The relationship between the visual-haptic and the concrete-formal continua was evaluated using a Pearson Product Moment Correlation, a scatter

diagram, the eta statistic, the polynomial trends option of the regression analysis technique, and the segregation of subjects into concrete-haptic, concrete-visual, formal-haptic, and formal-visual cells based upon their Successive Perception Test and Piagetian Classification Test scores.

Pearson Product Moment correlations, scatter diagrams, and the eta statistic were used to evaluate the relationships between age and perceptual aptitude, and age and intellectual reasoning abilities.

Fisher's F-tests were used to evaluate the relationships between sex, academic goal, and academic preference and an individual's position on either the visual-haptic or the concrete-formal continuum.

Research Questions and Specific Findings

This section includes a statement of the research questions, and the specific findings related to each question.

1. Is there a relationship between an individual's position on the visual-haptic continuum and his position on the concrete-formal continuum?

A Pearson r of .34 (r^2 = .11, $p \leq .00001$) was obtained when Successive Perception Test scores were compared with Piagetian Classification Test scores. A scatter diagram of the relationship, however, suggested it to be curvilinear. Curvilinearity was confirmed by comparing the eta^2 (.22) (Mueller, & Schuessler, 1961) value for the relationship (eta = .47 with the Piagetian Classification Test as the dependent variable) with the r^2 derived from the Pearsonian r ($eta^2 \neq r^2$). The eta^2 value attributed 22% of the intellectual level variation to perceptual aptitude.

INSERT TABLE 1 HERE

2. Is there a relationship between age and the individual's position on either continuum?

The correlation between age and Successive Perception Test scores was -.18 (r^2 = .03), and the correlation between age and the Piagetian Classification Test scores was -.04 (r^2 = .002). Inspection of the scatter diagrams for both age with the Successive Perception Test and age with the Piagetian Classification Test show each comparison to be nonlinear. This was confirmed by comparing the eta^2 values for both relationships with the r^2 values for both. The eta^2 value for the age-Successive Perception Test comparison was .36 (eta = .60) and the eta^2 value for the age-Piagetian Classification Test score relationship was .436 (eta = .66). The eta^2 values attributed 36% of the variation in perceptual aptitude to age and 43.6% of the variation in intellectual level to age.

INSERT TABLE 2 HERE

3. Is there a relationship between sex and the position an individual occupies on either continuum?

F-tests were run on the sex with Successive Perception Test and sex-Piagetian Classification Test relationships. The F-values respectively for these relationships were 9.60 (p = .002) and 6.28 (p = .01). Males were more visually oriented and more formally operational than females.

INSERT TABLE 3 HERE

4. Is there a relationship between academic preference and a person's location on either continuum?

Academic preferences were compared on both the Successive Perception Test and the Piagetian Classification Test using a oneway analysis of variance. The relationship on the Successive Perception Test was found to be significant at the .001 level (F = 5.0274). The comparison on the Piagetian Classification Test was significant at the .002 level (F = 3.428).

The academic preference categories arranged from lowest to highest mean perceptual aptitude score were, mathematics, business subjects, social sciences, languages, fine arts, biological sciences, physical sciences, and history. The arrangement based upon mean intellectual level score was business, fine arts, social sciences, physical sciences, mathematics, biological sciences, and languages (there was a void in the history category of the Piagetian Classification Test because of an absence on the day the instrument was administered).

INSERT TABLE 4 HERE

5. Is there a relationship between academic goal and a person's position on either continuum?

F-tests were run on the academic goal with Successive Perception Test and academic goal-Piagetian Classification Test relationships. The F-values for these relationships respectively were 2.339 (p = .07) and 3.428 (p = .002). In order of increasing mean Successive Perception Test and Piagetian Classification Test scores, the academic goal categories were AAS, BS, MS, and doctorate.

INSERT TABLE 5 HERE

6. Do subjects segregate as, (a) concrete-haptic, (b) concrete-formal, (c) formal-haptic, (d) formal-visual?

Subjects were found to segregate into these categories when divided at the mean Successive Perception Test score (17.9) and the mean Piagetian Classification Test score (19.7). The segregation was as follows, (a) concrete-haptic, 26%, (b) concrete-visual, 16%, (c) formal-haptic, 23% (d) formal-visual, 35%.

INSERT TABLE 6 HERE

7. Is there an equation which will allow prediction of intellectual level based upon perceptual aptitude?

A stepwise multiple regression analysis was run using the polynominal trends option (Piagetian Classification Test scores were used as the dependent variable) to produce a predictor equation based upon a line which best fit the data. The regression analysis used the first, second, third, and fourth powers of perceptual aptitude as independent variables. The equation derived from this technique was; intellectual level = 31.04 + 5.17 (perceptual aptitude) + $(1\text{-}.19)^2$ (perceptual aptitude)^2 + $(.002)^3$ (perceptual aptitude)^3. This equation had a standard error of 1.91, and attributed 83% of the intellectual level variance to perceptual aptitude.

INSERT FIGURE 1 HERE

8. Does the Piagetian Classification Test scale?

The instrument formed a hierarchial scale (Gulbman, 1944) in which all of the formal level items except item number 20 were more difficult than all of the concrete level items. Item number 20 was found to be less difficult than concrete level items number five, 14, and 22.

Finally, the reliabilities for the Successive Perception Test and Piagetian Classification Test were .62, and .859 respectively.

INSERT TABLE 7 HERE

Interpretations and Implications of the study

The major finding of the study was that perceptual aptitude and intellectual level were related in a curvilinear manner which attributed 83% of their variance to some common factor. The curviliniar model of the relationship in this study had two inflections (the number of inflections is always one less than the highest powered exponent in an equation). This finding was unexpected; however, it does support and in turn is supported by the fact that the subjects were categorizible as concrete-haptic, concrete-visual, formal-haptic, and formal-visual. The use of perceptual aptitude as a predictor of intellectual level and the converse, however, should be used with caution unless the curvilinearity of the relationship is fully understood.

A second finding was that age and perceptual aptitude and age and intellectual level were related in a curvilinear manner. It was expected that a positive relationship would be found between age and intellectual level, since according to Piaget (1972) not everyone is expected to be fully formal by age

15 or 16; success in attaining this level by this age may be couched in socioeconomic background.

Another finding was that to some extent academic goal is a viable predictor of either perceptual level or intellectual level. However, when a high perceptual aptitude or intellectual level is suggested using academic goal as a predictor, it does not necessarily follow that a high perceptual aptitude or intellectual level socre will also be obtained.

The finding that age was curvilinearly related to perceptual aptitude tends to support Flick's (personal communication, July 8, 1976) observation that as individuals advance in age, they tend to become more visual and that at some age, their perceptual aptitudes start to shift in a haptic direction.

The results of the study show a significant relationship between sex and both perceptual aptitude and intellectual level. Males are more visually oriented and more abstract thinkers than females. There is little documentary evidence in the case of perceptual aptitude to support or differ with the sex related finding of this study. The sex-intellectual level finding of this study is in agreement with Elkind (1961), Field (1969), Piburn (1977), and Heller (1977).

The usefulness of academic preference as a predictor of perceptual aptitude or intellectual level is questionable based upon the results of this study. However, the use of academic preference as a predictor lessened because all of the subjects from Maine Maritime Academy preferred the physical sciences, and all the subjects from Norwich University and Drake University preferred the social sciences. Before this variable can be categorically ruled out as a predictor of either perceptual aptitude or intellectual level, the topic needs more research.

The results of the scaling technique showed the Piagetian Classification Test to form a Guttman scale except in the case of test item number 20. Item 20 was the only formal item found to be less difficult than all of the concrete level items. It was less difficult than concrete items five, 14, and 22 not only because of the number of subjects successfully answering the item but also because of the number of subjects passing the item that should have failed it and the number of subjects failing the item who should have passed it (based upon subject performance in responding to items previous to this one). The results of the scaling technique suggest that the Piagetian Classification Test provides a reasonable measure of an individual's location on the concrete-formal continuum.

Conclusions

The following conclusions can be drawn from the finding of this study.

1) The results support the idea that there is a relationship between the Lowenfeldian visual-haptic continuum and the Piagetian concrete-formal continuum. The model of the relationship is curvilinear and in the case of this study, the best fit line had two inflections. In addition, the curvilinear model of the perceptual aptitude intellectual ability accounts for a major portion of the observed variance between the two continua.

2) Age is related to both perceptual aptitude and intellectual level in a curvilinear manner.

3) The findings support the idea that sex is related to intellectual level, and that generally, males are more abstract thinkers than females.

4) The findings of this study suggest that males are more visually oriented than females.

5) Academic preference is not a viable predictor of either perceptual aptitude or intellectual level.

6) The finding suggest that a specific academic goal may be predictive of an individual's perceptual aptitude and intellectual level. However, it may also be concluded that since academic goal has not yet been reached at the time an individual states the goal, both perceptual aptitude and intellectual level are predictive of academic goal. The more visually oriented or the more intellectually advanced an individual is, the higher that individual's eventual academic goal is likely to be.

7) The data supports the idea that Longeot's Piagetian Classification Test is hierarchical and therefore capable of identifying a location within the concrete-formal continuum.

8) The categorization of subjects into a four cell concrete-haptic, concrete-visual, formal-haptic, and formal-haptic matrix, suggests that some very formal people override the generally linear relationship between concrete-formal and visual-haptic abilities. These individuals, while being very abstract thinkers may be haptically oriented. This finding supports the findings of Roe (1952).

9) The curvilinear finding between concrete-formal and visual-haptic abilities suggests that there is a need for reevaluation of much of the data collected by previous researchers. It might be hypothesized that some strong relationships would be found between the concrete-formal and field-dependent-field-independent, and between field-dependent-field-independent and visual-haptic continua if the data of former researchers were evaluated using curvilinear techniques.

Table 1

Product Moment Correlation and Eta Values for the Comparison Between the Successive Perception Test and Piagetian Classification Test

	Mean	SD	Significance of r	r	r^2	eta	eta^2	Number of Observations
Successive Perception Test	17.8	4.7	.00001	.34	.11	.47	.22	279
Piagetian Classification Test	19.7	4.6						284

Table 2

Product Moment Correlation and Eta Values for the Relationships Between Age and Successive Perception Test scores and Age and Piagetian Classification Test Scores

	Mean	SD	Significance of r	r	r^2	eta	eta^2
Age	255.5	56.6	.002				
Succssive Perception Test				-.18	.03	.60	.36
			.55				
Piagetian Classification Test				-.04	.001	.66	.436

Table 3

Means, Standard Deviations, and F Values for the Comparisons Between Males' and Females' Scores on the Successive Perception Test and the Piagetian Classification Test

	Successive Perception Test		Piagetian Classification Test	
	Male	Female	Male	Female
Mean Score	18.96	17.1	20.4	19.1
Standard Deviation	4.65	4.71	4.1	4.97
No. of Observations	152	127	151	131
F Value	9.60		6.28	
Signif. of F	.002		.01	

Table 4

Means, Standard Deviations, and F Values for the Comparisons Between Academic Preference Categories on the Successive Perception Test and the Piagetian Classification Test

	Successive Perception Test			Piagetian Classification Test		
	Mean	SD	# of Ob.	Mean	SD	# of Ob.
Phy Sci	19.9	4.2	104	20.5	3.9	104
Bio Sci	19.0	3.3	10	21.8	3.1	9
Math	14.5	5.3	4	21.8	6.1	4
Languages	17.1	4.4	8	22.3	2.1	7
Soc Sci	16.7	3.8	64	20.4	5.0	64
Fine Arts	18.8	5.6	6	20.0	5.6	5
History	20.0	0.0	1			
Bus Subj	16.4	5.4	80	17.7	4.8	71
F Values	5.0274			3.428		
Sign. of F	.001			.002		

Table 5

Means, Standard Deviations, and F Values for the Comparisons Between Test and the Piagetian Classification Test

	Successive Perception Test			Piagetian Classification Test		
	Mean	SD	# of Ob.	Mean	SD	# of Ob.
AAS	17.0	4.6	69	16.8	4.3	64
BS	17.9	4.6	136	20.7	4.4	129
MS	18.7	5.1	67	21.0	4.2	66
Doctorate	21.4	5.9	5	21.4	4.9	5
F Values	2.349			3.428		
Sign. of F	.07			.002		

Table 6

Concrete-Haptic, Concrete-Visual, Formal-Haptic, and Formal-Visual Cell Frequencies and Percentages

	Concrete (0-19)	Formal (20-28)
Haptic (0-17)	66, 26%	58, 23%
Visual (18-35)	41, 16%	89, 35%

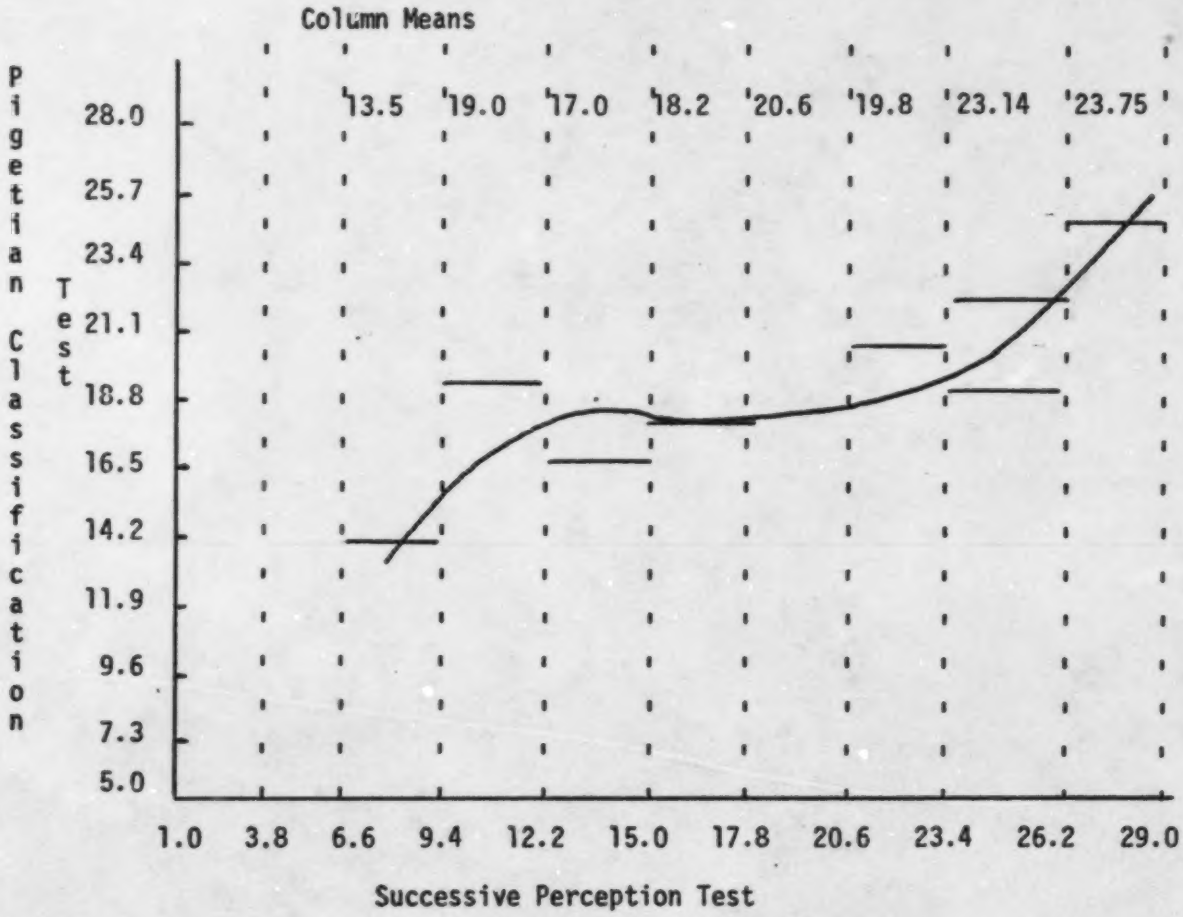

Figure 1

Curvilinear Relationship Between Successive Perception Test and Piagetian Classification Test Scores

Table 7

Scaling of Piagetian Classification Test Items From Least to Most Difficult

Test Item No.	Item Type	No. Passing Item	% Passing Item	No. Failing Item	% Failing Item	
1	C	268	93	20	7	
13	C	267	93	21	7	
3	C	265	92	23	8	I
12	C	263	91	25	9	N
4	C	263	91	25	9	C
21	C	261	91	27	9	R
15	C	257	89	31	11	E
2	C	254	88	34	12	A
23	C	253	88	35	12	S
20	F	248	86	40	14	I
14	C	248	86	40	14	N
5	C	248	86	40	14	G
22	C	246	85	42	15	
19	F	232	81	56	19	
25	F	220	76	68	24	D
16	F	213	74	75	26	I
18	F	197	68	91	32	F
24	F	193	67	95	33	F
17	F	191	66	97	34	I
9	F	165	57	123	43	C
26	F	149	52	139	48	U
6	F	148	51	140	49	L
7	F	136	47	152	52	T
28	F	133	46	155	54	Y
27	F	122	42	166	58	
10	F	112	39	176	61	
11	F	103	36	185	64	
8	F	17	6	271	91	

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